from said upper part, and said ground layer covering the surface of said insulating film in said depressed part; and

an electroconductive layer embedded in said depressed part via said ground layer.

REMARKS

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached Appendix is captioned "**Version with markings to show changes made.**"

As a preliminary matter, in the Office Action the Examiner indicated that Claim 37 was pending and has been withdrawn. However, Applicant would like to point out that the instant application does not include Claim 37 (the highest numbered claim is Claim 36, which was added in the Preliminary Amendment filed on March 8, 2000).

Claims 1 and 3-7 stand rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 4,990,997 to Nishida. Applicant respectfully traverses this rejection.

Applicant respectfully submits that Nishida fails to disclose all of the features of the present invention as defined in independent Claims 1 and 5. In particular, Nishida fails to disclose an embedded electroconductive layer that includes, *inter alia*, a barrier layer and a metal growth promoting layer where the "metal growth promoting layer [is] made of a material different from that of said barrier layer," as defined in independent Claim 1. With

regard to independent Claim 5, Applicant respectfully submits that Nishida fails to disclose an embedded electroconductive layer that includes, *inter alia*, a ground layer containing a high concentration of oxygen in its lower part and a low concentration of oxygen in its upper part "due to removal of oxygen from said upper part."

In contrast to the invention defined by independent Claim 1, in which the barrier layer and the metal growth promoting layers are of different materials, the barrier metal layer 15 and the interface region 16' of Figures 3(A) to 3(F) of Nishida, which the Examiner has equated, respectively, with the claimed barrier layer and the claimed metal growth promoting layer, are both of the same material.

In column 5, lines 42-52, the Nishida reference discusses that the interface region 16' is an amorphous layer of the barrier metal layer 15 that is formed "in the layer 15 adjacent the top surface 16" (column 5, line 42; emphasis added) by ion implantation of titanium and the like. Similarly, Claim 1 of Nishida defines the interface region as being "formed in the first barrier layer as a part of the first barrier layer." (Column 9, lines 41-42; emphasis added). As an alternative to ion implantation, the interface region 16' may simply be a thin region of the barrier metal layer 15 that has been oxygenated to erase the grain boundary from the surface. (Column 5, lines 50-61). Thus, the same material is used in the barrier metal layer 15 and in the interface region 16', except the interface region 16' has been oxygenated or treated with ion implantation. Accordingly, the barrier metal layer 15 and the interface region 16' of Nishida do not satisfy the barrier layer and the metal growth

promoting layer of Claim 1 because these two layers of Nishida are not made of different materials.

In addition, the second barrier metal layer 17 and the first barrier metal layer 15 of Nishida are also made of the same material (see the Abstract of Nishida). Accordingly these two layers can not be considered as the claimed barrier layer and the claimed metal growth promoting layer of Claim 1 either.

Thus, since the Nishida reference lacks all of the features defined in independent Claim 1, Applicant respectfully requests the withdrawal of this §102(e) rejection.

Claims 3 and 4 both depend from independent Claim 1, and therefore include all of the features of Claim 1, plus additional features. Accordingly, Applicant respectfully requests that the §102(e) rejection of dependent Claims 3 and 4 under Nishida be withdrawn considering the above remarks directed to independent Claim 1.

With regard to independent Claim 5, Applicant respectfully submits that the Nishida reference fails to disclose a ground layer with an upper part with oxygen at a low concentration "due to removal of oxygen from said upper part," as defined in independent Claim 5.

Nishida includes a barrier layer (with upper and lower layers 16, 17) and a wiring layer 18 on the barrier layer. Nishida further includes an interface layer 16' between the upper barrier layer (17) and the lower barrier layer (16). The interface layer 16' functions

to prevent diffusion of the wiring metal by defining a non-continuous grain boundary between the upper and lower barrier layers. The interface layer 16' is created by introducing oxygen (or another material) to the material of the lower barrier layer 16. However, Nishida does not disclose the removal of oxygen from the upper barrier layer, as defined in Claim 5.

In contrast, in the present invention of Claim 5, the upper portion of the barrier layer is etched to remove its oxygen included layer before a wiring layer is grown upon the barrier layer. Additionally, the upper portion of the barrier layer, which is preferably intended to function as a metal growth promoting layer, is exposed to a reducing agent to remove oxygen. Because of the low concentration of oxygen in the upper portion of the barrier layer, the incubation time for the electroconductive layer that is grown on top of the barrier layer is reduced. (Page 23, line 33 through page 24, line 2). However, since the lower portion of the barrier layer still includes a high concentration of oxygen, the barrier properties of the barrier layer are retained. (Page 24, line 3-8).

Accordingly, since the Nishida reference lacks all of the claimed features defined in independent Claim 5, Applicant respectfully requests the withdrawal of this §102(e) rejection of Claim 5.

Claims 6 and 7 both depend from independent Claim 5, and therefore include all of the features of Claim 5, plus additional features. Accordingly, Applicant respectfully requests that the §102(e) rejection of dependent Claims 6 and 7 under Nishida be withdrawn considering the above remarks directed to independent Claim 5.

Claim 2 stands rejected under 35 U.S.C. §103 as being unpatentable over Nishida in view of U.S. Patent No. 5,739,579 to Chiang et al. Applicant respectfully traverses this rejection.

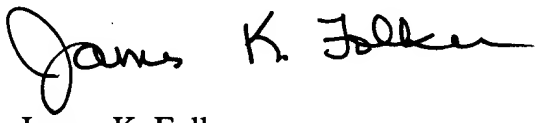
Claim 2 depends from independent Claim 1, and therefore includes all of the features of Claim 1, plus additional features. Accordingly, Applicant respectfully requests that the §103 rejection of dependent Claim 2 under Nishida and Chiang et al. be withdrawn considering the above remarks directed to independent Claim 1, and also because the Chiang et la. reference also fails to disclose or suggest the claimed metal growth promoting layer sandwiched between a barrier layer and an electroconductive layer, nor was this reference relied upon for this feature.

For all of the above reasons, Applicant requests reconsideration and allowance of the claimed invention. The Examiner is invited to contact the undersigned attorney if an interview would expedite prosecution.

Respectfully submitted,

GREER, BURNS & CRAIN, LTD.

July 9, 2001

By 

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

The paragraph beginning on page 1, line 15 has been amended as follows:

--For the purpose of lowering the resistance offered by [a] an interconnection layer, the feasibility of substituting a Cu interconnection layer for the conventional A1 interconnection layer has been the subject of a diligent study. Cu has lower resistivity than A1 and about twice as high electromigration resistance as A1.--

The paragraph beginning on page 1, line 22 has been amended as follows:

--Generally, the formation of a layer of fine wiring lines requires [to] [resort] resorting to dry etching.--

The paragraph beginning on page 4, line 22 has been amended as follows:

--In contrast, in the CVD-TiN layer with excellent step coverage, substantially no oxygen was detected except on the surface as shown in Fig. 2B. This contrast may be logically explained by a supposition that since the PVD-TiN layer had small crystal grain particles are compared with the [PVD-TiN] CVD-TiN layer, the former layer permitted easier entrance of oxygen from the ambient air than the latter layer.--

In the Claims:

Claim 1 has been amended as follows:

1. (Once Amended) An embedded electroconductive layer comprising:

[an opening part or] a depressed part formed in an insulating film on a substrate;

a barrier layer covering said [opening part or] depressed part;

a metal growth promoting layer on said barrier layer, said metal growth promoting layer being made of a material different from that of said barrier layer; and

an electroconductive layer embedded in [said opening part or] said depressed part via said barrier layer and said metal growth promoting layer.

Claim 3 has been amended as follows:

3. (Twice Amended) The embedded electrconductive layer according to claim 1 [claim,] wherein said metal growth promoting layer is a TiN layer containing oxygen at a lower concentration than said barrier layer.

Claim 5 has been amended as follows:

5. (Once Amended) An embedded electroconductive layer comprising:

[an opening part or] a depressed part formed in an insulating layer on a substrate;

a ground layer containing oxygen at a high concentration in the lower part thereof and at a low concentration in the upper part thereof due to removal of oxygen from said upper part, and said ground layer covering the surface of said insulating film in [said opening part or] said depressed part; and

an electroconductive layer embedded in [said opening part or] said depressed part via said ground layer.